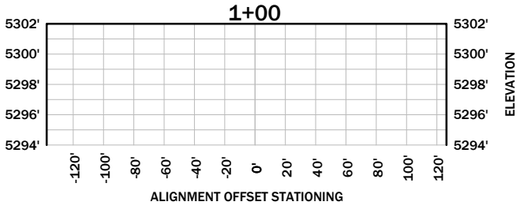

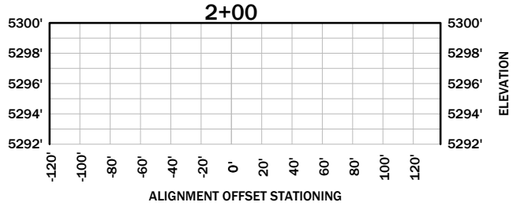

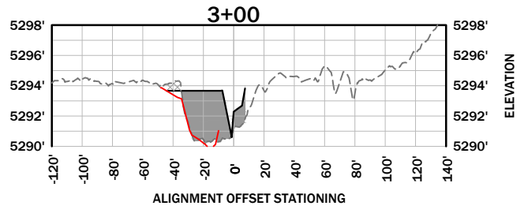

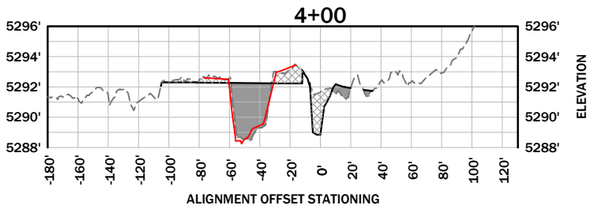

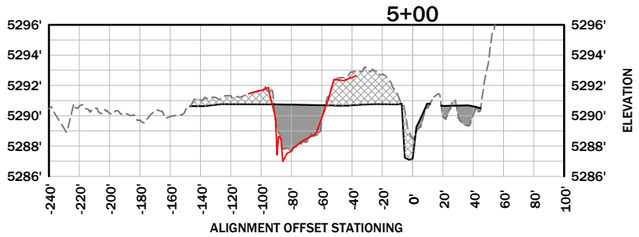

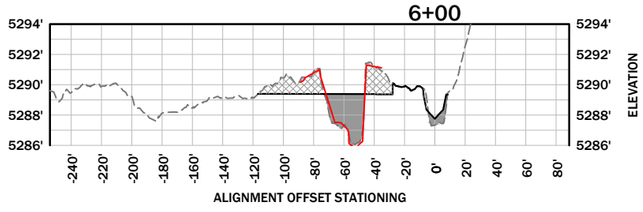

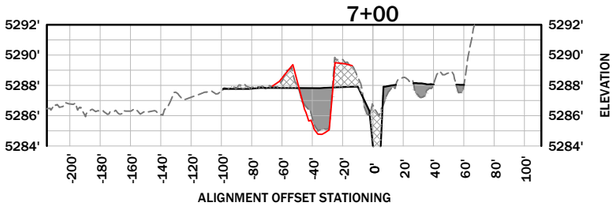

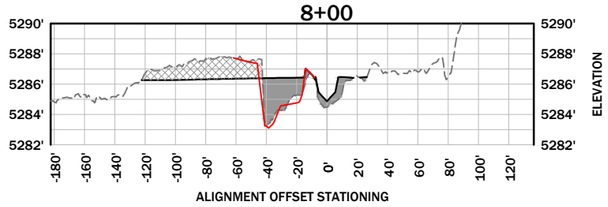

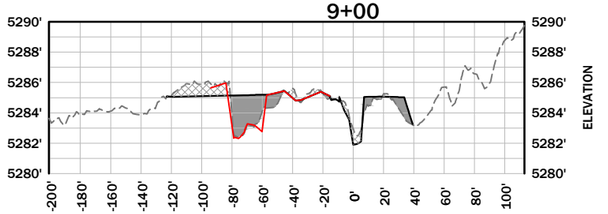

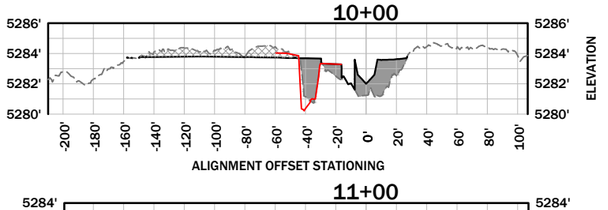

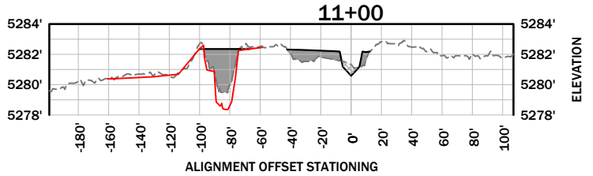

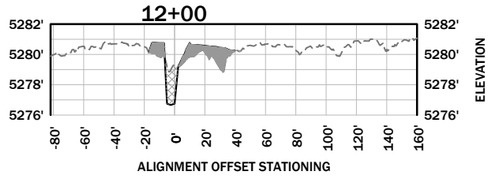

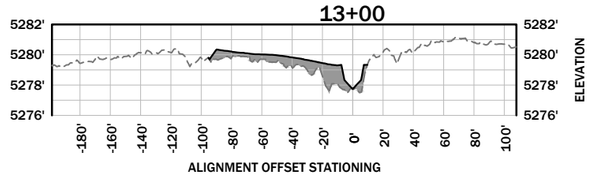

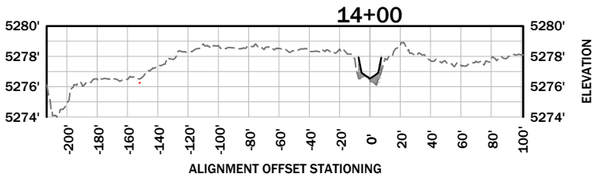

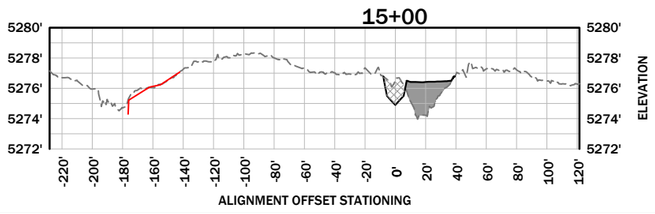

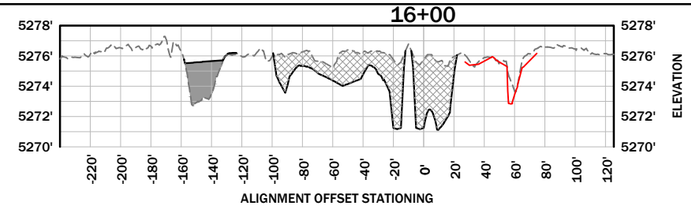

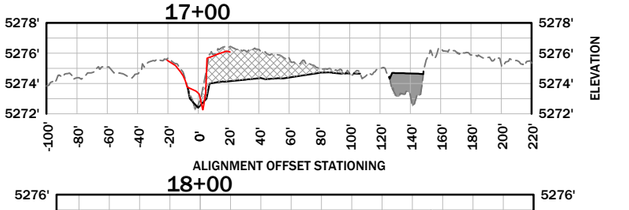

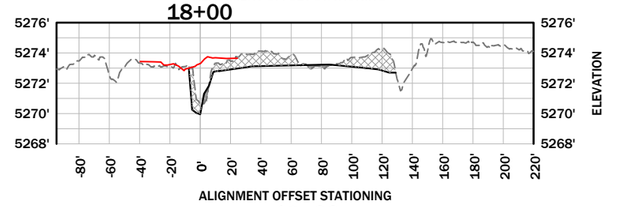

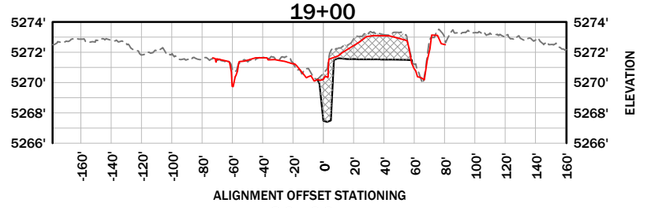

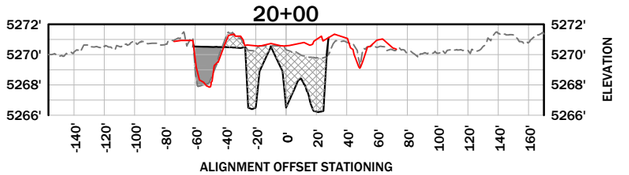

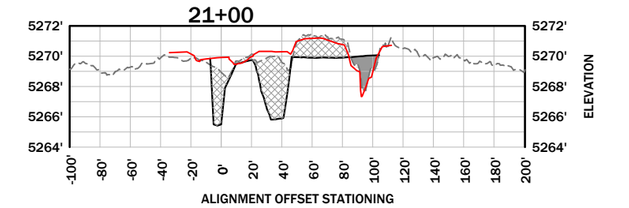

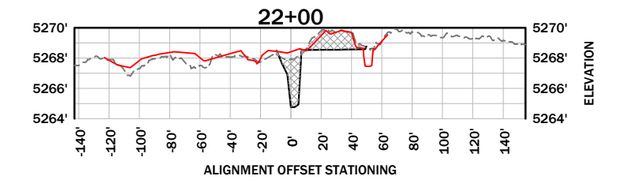

LEGEND

EXISTING GROUND 2019

EXISTING GROUND

DESIGN SURFACE

CUT

FILL

NOTE: CROSS SECTIONS ARE SHOWN LOOKING DOWNSTREAM PERPENDICULAR TO THE VALLEY ALONG THE CHANNEL ALIGNMENT.

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CROSS SECTIONS

UPPER SPOTTED DOG CREEK

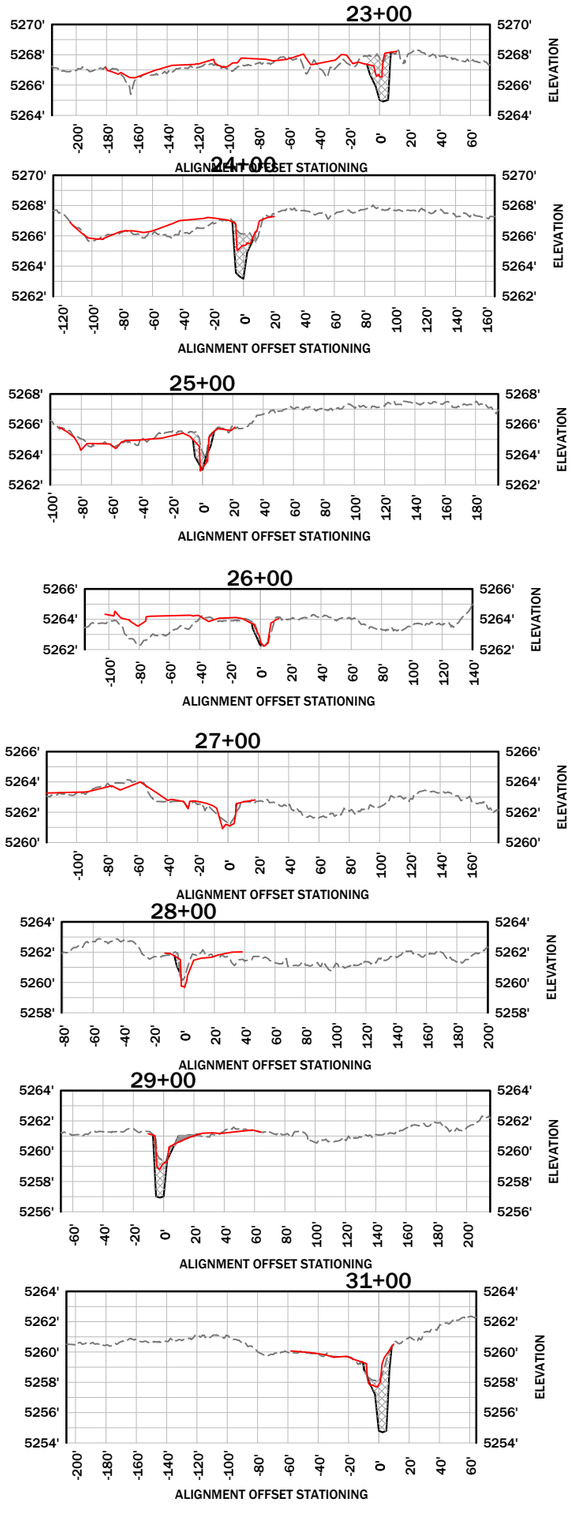
NEAR AVON, MONTANA

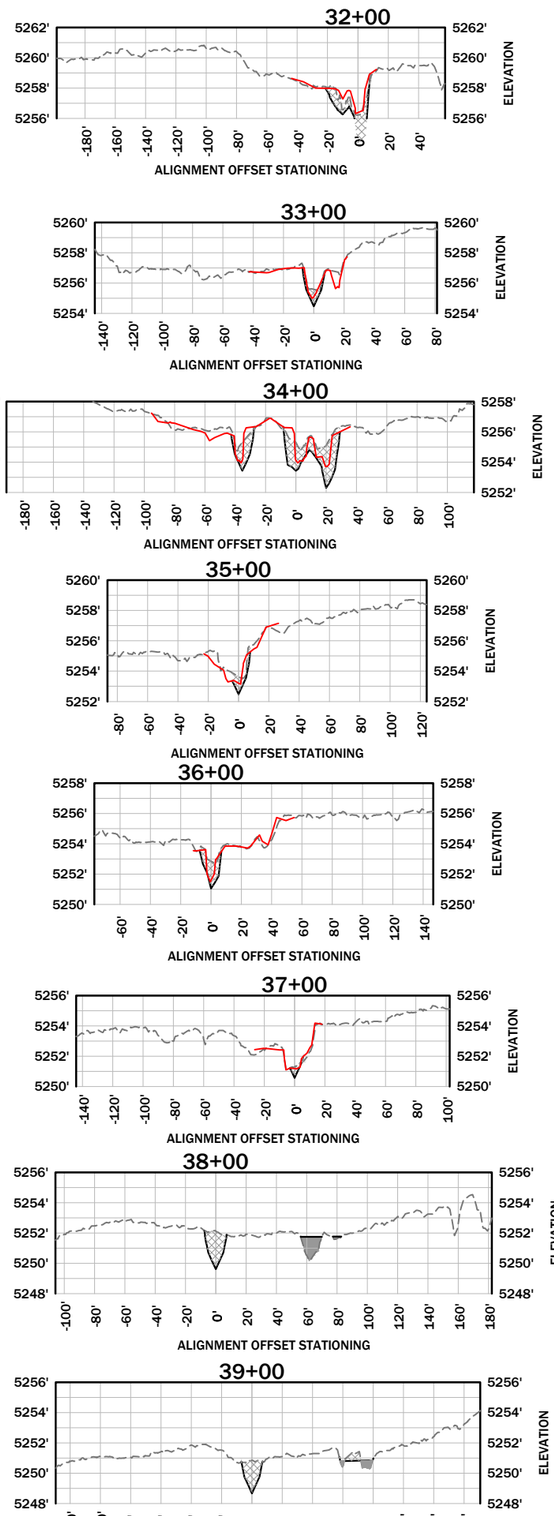
NO.	DATE	BY	DESCRIPTION	CHK
1	3-11-16	NW	DESIGN	MD
2	1-02-20	NW	DESIGN REVISIONS	MD

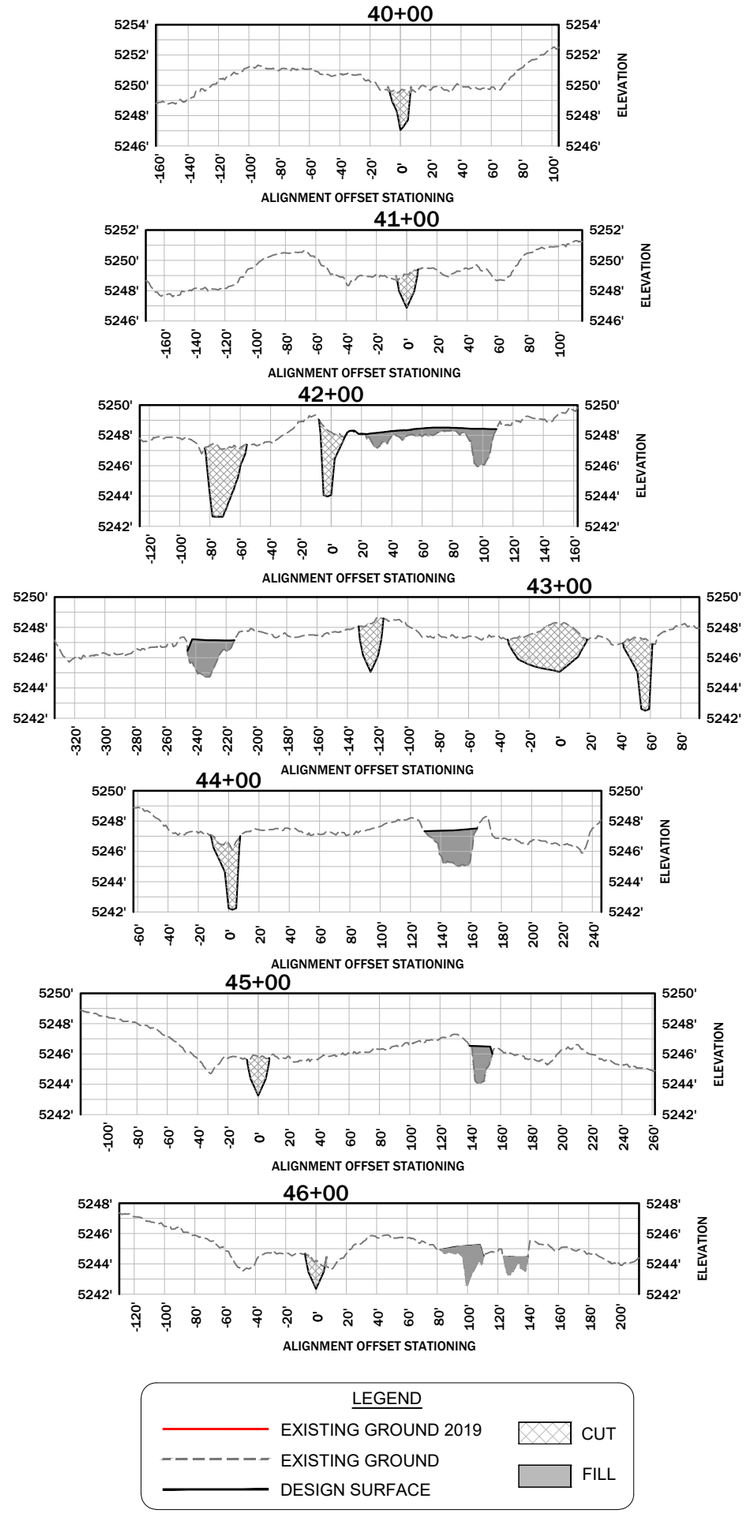
PROJECT NUMBER
RDG-15-053

SHEET NUMBER

6.0







LEGEND

- EXISTING GROUND 2019
- EXISTING GROUND
- DESIGN SURFACE
- CUT
- FILL

NOTE: CROSS SECTIONS ARE SHOWN LOOKING DOWNSTREAM PERPENDICULAR TO THE VALLEY ALONG THE CHANNEL ALIGNMENT.

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CROSS SECTIONS

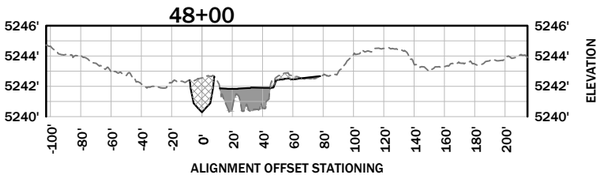
UPPER SPOTTED DOG CREEK NEAR AVON, MONTANA

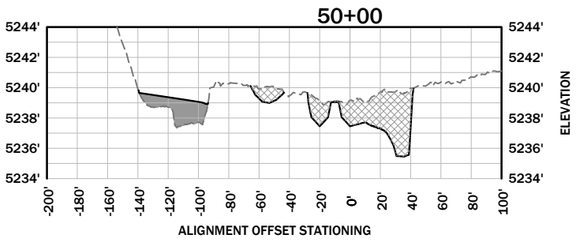
NO.	DATE	BY	DESCRIPTION	CHK
1	3-11-16	NW	DESIGN	MD
2	1-02-20	NW	DESIGN REVISIONS	MD

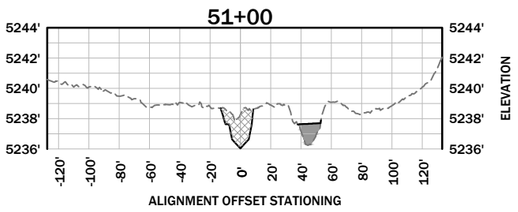
PROJECT NUMBER
RDG-15-053

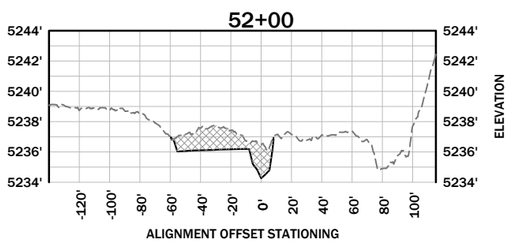
SHEET NUMBER

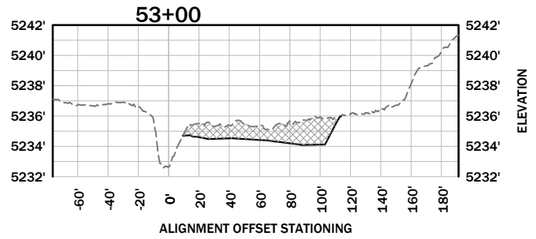
6.1

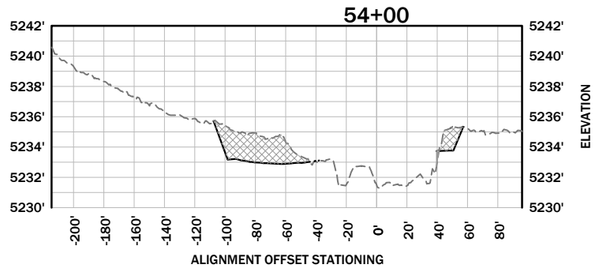


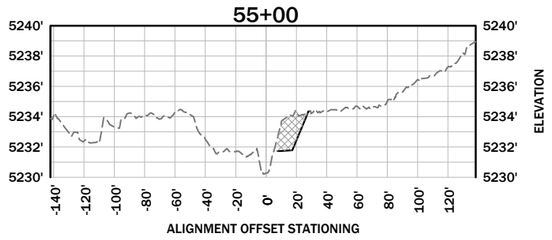


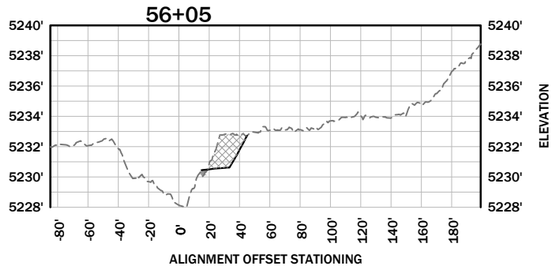


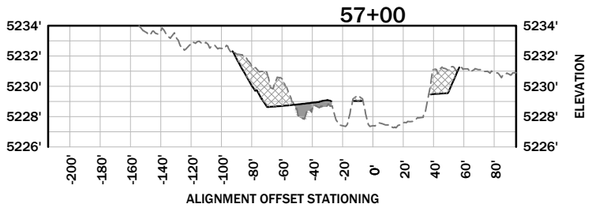


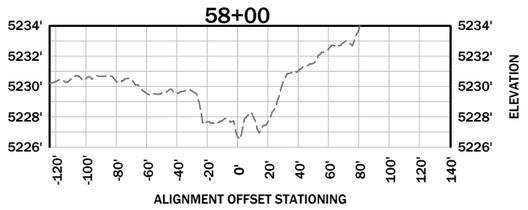


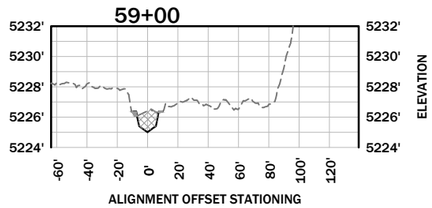












LEGEND

EXISTING GROUND

DESIGN SURFACE

CUT

FILL

NOTE: CROSS SECTIONS ARE SHOWN LOOKING DOWNSTREAM PERPENDICULAR TO THE VALLEY ALONG THE CHANNEL ALIGNMENT.

RDG RIVER DESIGN GROUP

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CROSS SECTIONS

UPPER SPOTTED DOG CREEK
NEAR AVON, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	3-11-16	NW	DESIGN	MD
2	1-02-20	NW	DESIGN REVISIONS	MD

PROJECT NUMBER
RDG-15-053

SHEET NUMBER

6.2

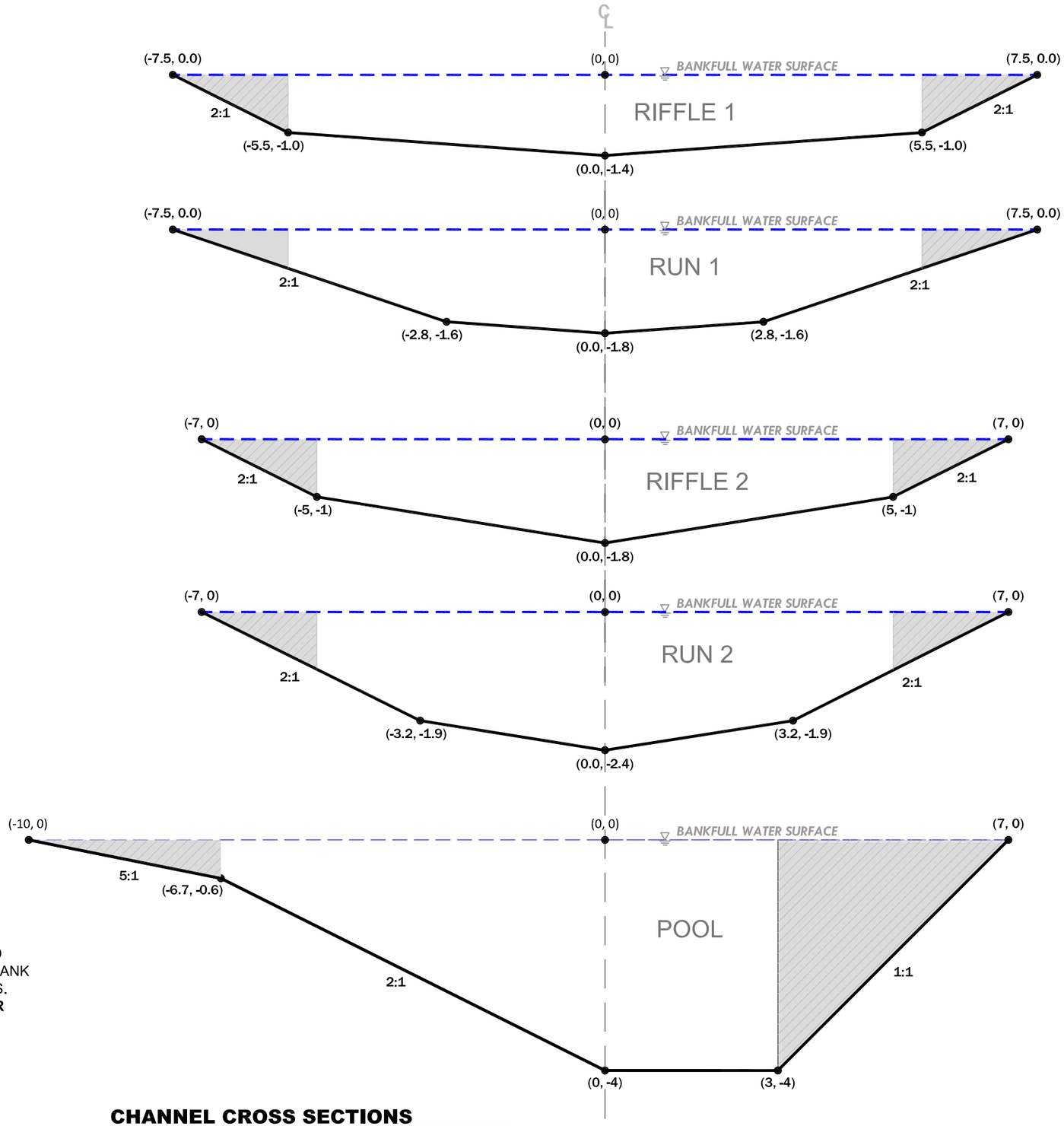
RIFFLE 1
STATION 0+00 TO 19+00
STATION 46+50 TO 61+82

BANKFULL CHANNEL DESIGN CRITERIA			
STREAM TYPE	E4		
DISCHARGE	45-50 CFS		
VALLEY SLOPE	0.022 FT/FT		
SINUOSITY	1.5		
CHANNEL SLOPE	0.015 FT/FT		
	RIFFLE	RUN	POOL
WIDTH	11-12 ft	11-12 ft	8-12 ft
MEAN DEPTH	1.0-1.1 ft	1.6 ft	1.1-1.2 ft
MAX. DEPTH	1.4-1.6 ft	1.8 ft	3.2-4.3 ft
XS AREA	12.5 sq ft	15.5 sq ft	18 sq ft
WIDTH:DEPTH	10-11	N/A	N/A

RIFFLE 2
STATION 19+00 TO 46+50

BANKFULL CHANNEL DESIGN CRITERIA			
STREAM TYPE	E4		
DISCHARGE	45-50 CFS		
VALLEY SLOPE	0.02 FT/FT		
SINUOSITY	2.2		
CHANNEL SLOPE	0.009 FT/FT		
	RIFFLE	RIFFLE	POOL
WIDTH	9-11 ft	9-11 ft	12-14 ft
MEAN DEPTH	1.3-1.5 ft	1.9 ft	1.4-1.6 ft
MAX. DEPTH	1.8 ft	2.4 ft	4.2-5.7 ft
XS AREA	14 sq ft	17 sq ft	20 sq ft
WIDTH:DEPTH	6-8	N/A	N/A

NOTE: CROSS SECTION DIMENSIONS ASSUME THAT SHADED AREAS WILL BE INEFFECTIVE FLOW AREAS DUE TO BANK TREATMENTS OR EXISTING VERTICAL STREAMBANKS. **DO NOT EXCAVATE SHADED AREAS IF GOOD SOD OR WOODY VEGETATION EXISTS.**



CHANNEL CROSS SECTIONS
TYPICAL

0' 1' 4'

NOTE: COORDINATES ARE REFERENCED FROM TOP OF BANK CENTERLINE

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TYPICAL CHANNEL DIMENSIONS

NO.	DATE	BY	DESCRIPTION	CHK
1	3-11-16	NW	DESIGN	MD

PROJECT NUMBER
RDG-15-053

SHEET NUMBER
7.0

DESIGN INTENT

PURPOSE: THE PURPOSE OF THIS STRUCTURE IS TO CREATE HYDRAULIC CONDITIONS THAT MAINTAIN A DEEP POOL.

PLACEMENT CRITERIA: THIS STRUCTURE IS DESIGNED TO FUNCTION ON A HIGH STRESS BANK WITH CONCAVE PLANFORM GEOMETRY. THE STRUCTURE IS TYPICALLY PLACED ON THE OUTER BANK OF A MEANDER BEND.

AQUATIC HABITAT OBJECTIVES ADDRESSED: THIS STRUCTURE CREATES COMPLEX HYDRAULICS SUCH AS EDDIES AND SECONDARY FLOW CIRCULATION. LARGE WOOD PROVIDES IN-STREAM COVER AND SHADE FOR TEMPERATURE REDUCTION. DEEP POOLS IMPROVE HYPORHEIC FLOW FOR TEMPERATURE MANAGEMENT. RESIDUAL POOLS PROVIDE LOW-VELOCITY HOLDING HABITAT AND OVER-WINTERING HABITAT.

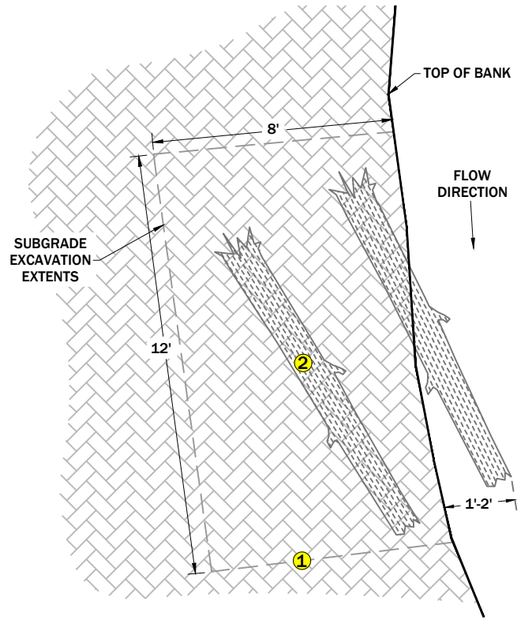
VEGETATION OBJECTIVES ADDRESSED: CREATES STABLE CONDITIONS TO SUPPORT DEVELOPMENT OF DESIRED VEGETATION COMMUNITY TYPES.

GEOMORPHIC OBJECTIVES ADDRESSED: THIS STRUCTURE SUPPORTS POOL DEVELOPMENT PROCESSES. POOLS PROVIDE PLANFORM VARIABILITY AND FOSTER POINT BAR DEVELOPMENT. THE STRUCTURE IS COMPOSED OF NATIVE MATERIALS.

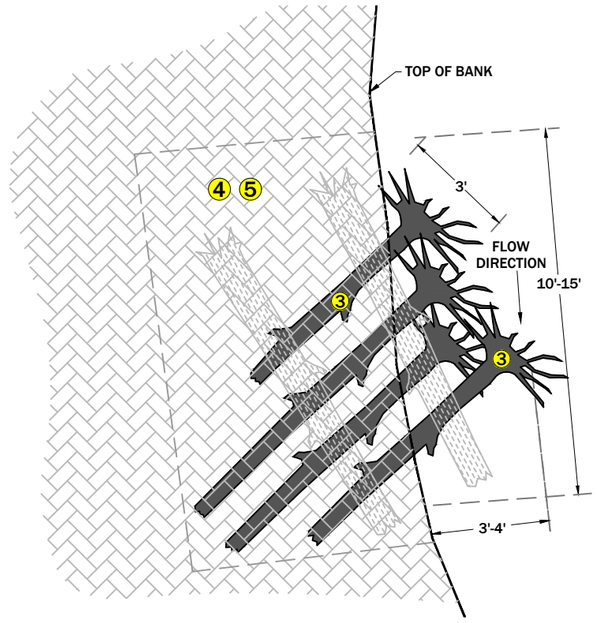
SUPPLEMENTAL INFORMATION: THE LARGE WOOD STRUCTURE PROVIDES TEMPORARY BANK PROTECTION BY RE-DIRECTING FLOW AWAY FROM THE BANK AND DISSIPATING FLOW ENERGY INTO THE RIVERBED. THE STRUCTURE CREATES COMPLEX HYDRAULICS AND TURBULENCE, WHICH REQUIRE ATTENTION TO HOW THE STRUCTURE IS TIED IN TO EXISTING FEATURES OR OTHER BANK STRUCTURES. MAINTAINING ADEQUATE BACKFILL BALLAST IS CRITICAL TO COUNTERACT BUOYANCY AND SLIDING/ROTATION OF WOOD. STRUCTURE PERFORMANCE IS DEPENDENT ON STRUCTURE SIZE AND USE OF ADEQUATELY-SIZED LARGE WOOD WITH INTACT ROOTWADS. EXCAVATION OF THE POOL IN CONJUNCTION WITH THE STRUCTURE IS RECOMMENDED. THE STRUCTURE WILL TEND TO RECRUIT ADDITIONAL WOODY DEBRIS. OVER TIME, THE STRUCTURE WILL DECOMPOSE OR BECOME ABANDONED/ BURIED IN THE FLOODPLAIN AS THE CHANNEL MIGRATES LATERALLY. INTEGRATING MATURE SHRUB TRANSPLANTS OR PLANTINGS ON THE FLOODPLAIN SURFACE BEHIND THIS STRUCTURE CREATES ROOTING STRUCTURE FOR LONG TERM BANK STABILITY.

CONSTRUCTION NOTES

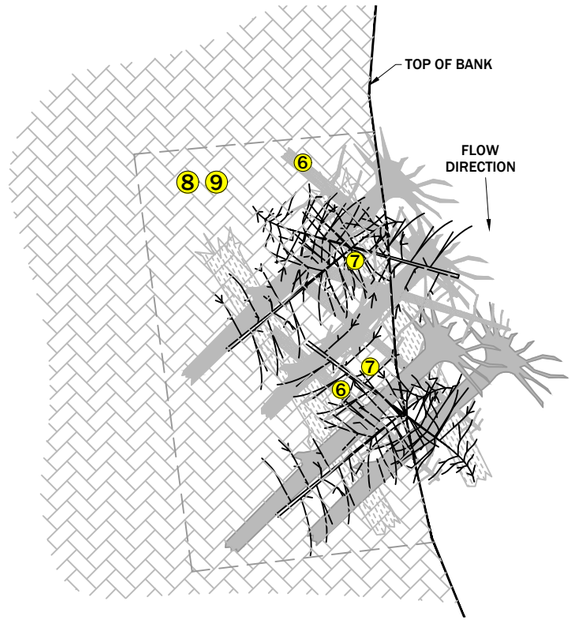
1. EXCAVATE STREAMBANK TO SUBGRADE ELEVATIONS.
2. PLACE TIER 1 FOOTER LOGS IN THE STREAMBANK POINTING DOWNSTREAM PER THE ORIENTATION SHOWN ON THE DRAWINGS.
3. PLACE TIER 2 ROOTWAD LOGS ON TOP OF FOOTER LOGS WITH ROOTWADS POINTING UPSTREAM. PLACEMENT SHALL BEGIN AT THE UPSTREAM END AND THE UPSTREAM ROOTWAD SHALL BE FLUSH WITH THE TOP OF BANK LINE. SUBSEQUENT ROOTWADS SHALL BE PLACED IN A DOWNSTREAM DIRECTION WITH GRADUALLY INCREASING PROJECTION INTO THE CHANNEL AS SHOWN ON THE DRAWINGS. ADJACENT ROOTWADS SHALL BE TOUCHING OR OVERLAPPING.
4. BACKFILL STREAMBANK TO THE TOP OF ROOTWAD LOGS WITH STREAMBANK FILL PER THE GRADATION SHOWN ON THE DRAWINGS.
5. WASH FINES AND WATER FROM ONSITE INTO THE STREAMBANK FILL TO SEAL THE VOIDS IN THE BACKFILL.
6. PLACE TIER 3 DEFLECTOR LOGS WITHIN THE MATRIX OF LOGS. LOGS SHALL BE WOVEN BETWEEN OTHER LOGS TO PREVENT MOVEMENT. DEFLECTOR LOGS SHALL POINT DOWNSTREAM AND MAY EXTEND UP TO TWO FEET ABOVE THE TOP OF BANK ELEVATION.
7. PLACE TIER 3 BRUSH RANDOMLY WITHIN THE MATRIX OF LOGS. BRUSH SHALL BE WOVEN BETWEEN OTHER LOGS TO PREVENT MOVEMENT. BRUSH MAY EXTEND UP TO TWO FEET ABOVE THE TOP OF BANK ELEVATION.
8. BACKFILL STREAMBANK TO THE TOP OF ROOTWAD LOGS WITH STREAMBANK FILL PER THE GRADATION SHOWN ON THE DRAWINGS.
9. WASH FINES AND WATER FROM ONSITE INTO THE STREAMBANK FILL TO SEAL THE VOIDS IN THE BACKFILL.
10. GRADE THE TOP OF BANK TO MATCH FINISHED GROUND ELEVATIONS.



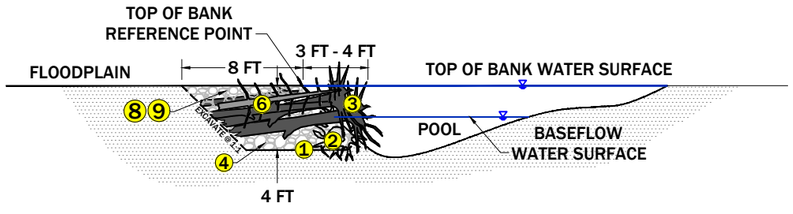
TIER 1 - FOOTER LOGS
PLAN VIEW
0' 2.5' 5'



TIER 2 - ROOTWAD LOGS
PLAN VIEW
0' 2.5' 5'



TIER 3 - DEFLECTOR AND BRUSH WOOD
PLAN VIEW
0' 2.5' 5'



LARGE WOOD STRUCTURE
SECTION VIEW
0' 5' 10'

STREAMBANK FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
8	100	D100
4-6	90 - 100	D95
2-4	50 - 80	D65
1-2	30 - 50	D35
0.5-1.0	10 - 30	D15
FINES	0	

MATERIAL SCHEDULE (PER STRUCTURE)

	ITEM	QUANTITY	DIA. (IN)	LENGTH (FT)	ROOTWAD (Y/N)
1	CY OF SUBGRADE EXCAVATION	15			
3	LARGE WOOD	4	12-18	8-10	YES-3 FT DIA. MIN.
2	MEDIUM WOOD	2	6-12	8-10	NO
6	SMALL WOOD	4	3-6	8-10	OPTIONAL 1-2 FT
7	BRUSH	4	1-3	8-10	OPTIONAL 1-2 FT
4 8	CY OF STREAMBANK FILL	5			

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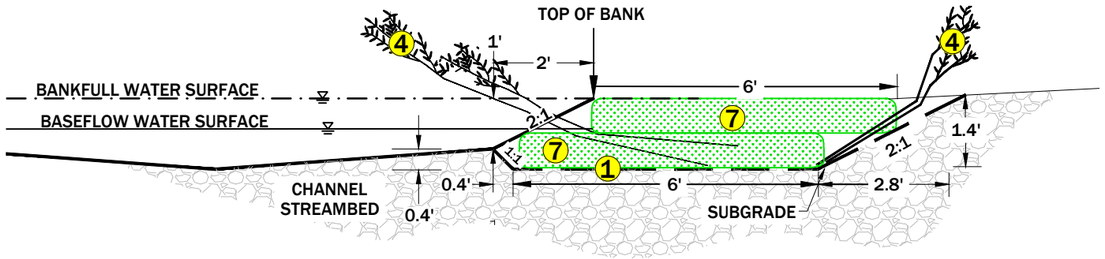
LARGE WOOD STRUCTURE
UPPER SPOTTED DOG CREEK
NEAR AVON, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	3-11-16	NW	DESIGN	MD
2	1-02-20	NW	DESIGN REVISIONS	MD

PROJECT NUMBER
RDG-15-053

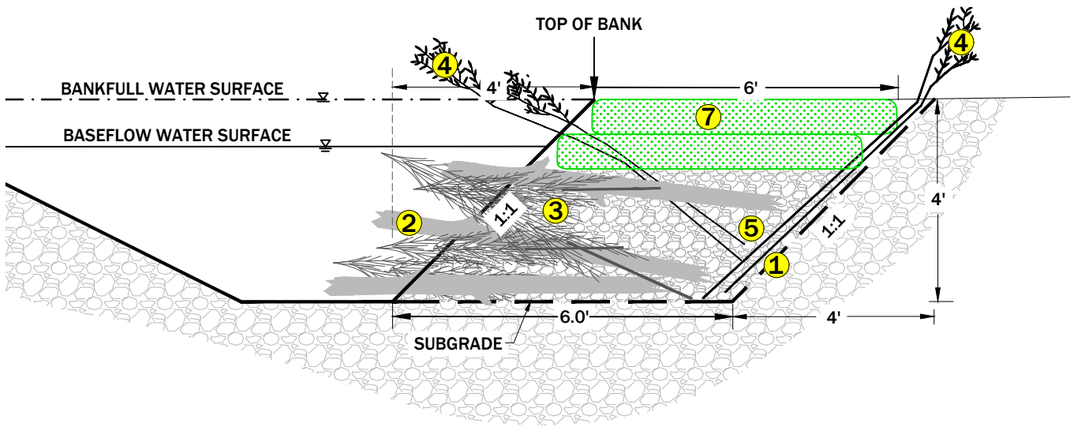
SHEET NUMBER
7.1



SOD AND BRUSH BANK

RIFFLE SECTION VIEW

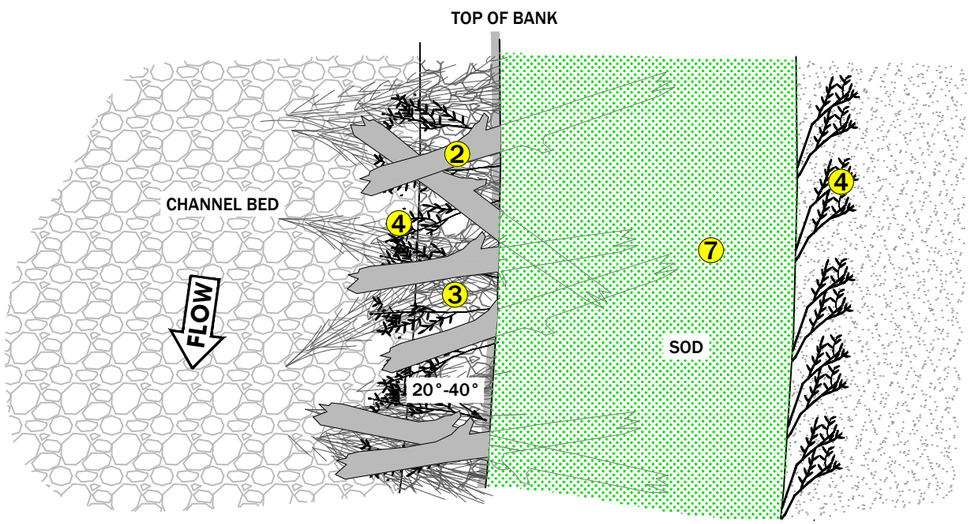
0' 1.5' 3'



SOD AND BRUSH BANK

POOL SECTION VIEW

0' 1.5' 3'



SOD AND BRUSH BANK

PLAN VIEW

0' 1.5' 3'

DESIGN INTENT

PURPOSE: THE PURPOSE OF THIS STRUCTURE IS TO CREATE A COMPLEX, VEGETATED BANK MARGIN THAT SUPPORTS AQUATIC HABITAT, VEGETATION AND GEOMORPHIC OBJECTIVES.

PLACEMENT CRITERIA: THIS STRUCTURE IS DESIGNED TO FUNCTION ON A MODERATE STRESS BANK WITH LOW TO MODERATE CURVATURE.

SUPPLEMENTAL INFORMATION: THE SOD AND BRUSH STRUCTURE INCORPORATES NATIVE MATERIALS TO PROVIDE PREFERRED HABITAT CONDITIONS ALONG STREAMBANKS. THE STRUCTURE IS BUILT ON A ROCK AND WOOD TOE. STRUCTURE PERFORMANCE IS DEPENDENT ON TOE STABILITY AS WELL AS SMOOTH TRANSITIONS TO STABLE UPSTREAM AND DOWNSTREAM TIE-IN POINTS. APPLICATION OF ADEQUATE BACKFILL AND SOD MAT BALLAST IS CRITICAL TO COUNTERACT BUOYANCY AND SLIDING/ROTATION OF WOOD. PLACEMENT OF WOOD UP TO 8 INCHES BELOW BANKFULL CAPPED WITH A SOD MAT AND PLACEMENT OF HEALTHY WOODY VEGETATION IN CONTACT WITH THE WATER TABLE THROUGHOUT THE GROWING SEASON IS CRITICAL FOR RAPID VEGETATION ESTABLISHMENT.

CONSTRUCTION NOTES

1. EXCAVATE STREAMBANK TO SUBGRADE ELEVATIONS.
2. PLACE SMALL LOGS IN THE STREAMBANK AT SKEWED ANGLE TO THE STREAMBANK. LOGS SHALL BE PLACED BELOW THE TOP OF BANK ELEVATION. LOGS MAY OVERLAP.
3. PLACE BRUSH WITHIN THE MATRIX OF SMALL LOGS. BRUSH SHALL PLACED BELOW TOP OF BANK LINE.
4. PLACE CUTTINGS INTO THE LOG/BRUSH MATRIX WITH THE STEMS IN CONTACT WITH THE BASEFLOW WATER TABLE AND THE LEAVES AT OR ABOVE THE BANKFULL WATER SURFACE ELEVATION.
5. BACKFILL STREAMBANK WITH STREAMBANK FILL PER THE GRADATION SHOWN ON THE DRAWINGS.
6. WASH FINES AND WATER FROM ONSITE INTO THE STREAMBANK FILL TO SEAL THE VOIDS IN THE BACKFILL.
7. PLACE A 8-10 INCH SOD MAT BEGINNING AT BANKLINE AND EXTENDING BACK 6 FEET IN TO FLOODPLAIN TO MATCH FINISHED GROUND ELEVATIONS. REFER TO VEGETATION SALVAGE PLAN FOR SOD SOURCES.

STREAMBANK FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
8	100	D100
4-6	90 - 100	D95
2-4	50 - 80	D65
1-2	30 - 50	D35
0.5-1.0	10 - 30	D15
FINES	0	

MATERIAL SCHEDULE (PER LINEAR FOOT)

	ITEM	RIFFLE QUANTITY	POOL QUANTITY	DIA. (IN)	LENGTH (FT)
1	CY OF SUBGRADE EXCAVATION	0.34	1		
5	CY OF STREAMBANK FILL	0	0.3		
2	SMALL WOOD	0	1	3-6	8-10
3	BRUSH WOOD	0	1	1-3	8-10
7	SEDGE SOD MAT	12 SF	12 SF	8-10 (THICK)	3 X 6
4	WILLOW CUTTINGS	5	5	0.75-1.5	6-8

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SOD AND BRUSH BANK
UPPER SPOTTED DOG CREEK
NEAR AVON, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
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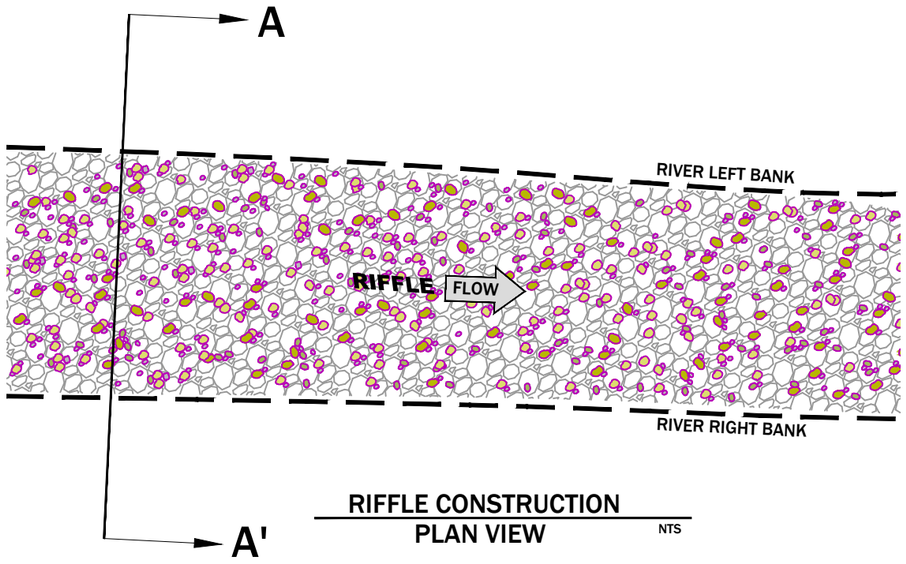
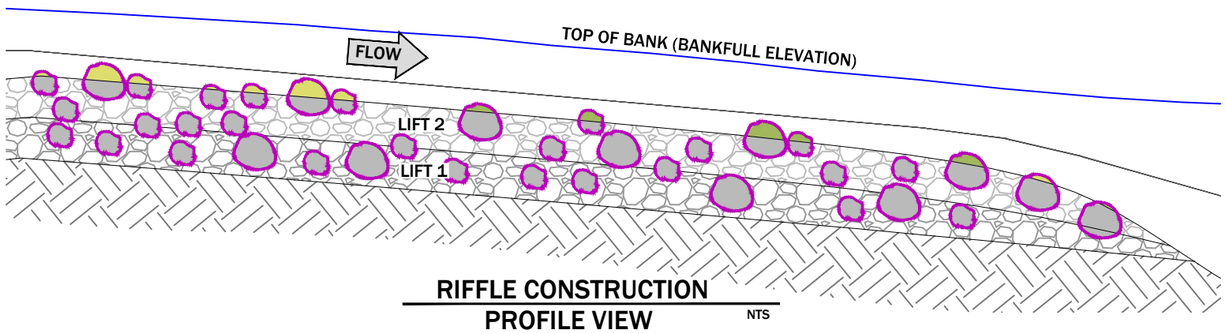
2	1-02-20	NW	DESIGN REVISIONS	MD

PROJECT NUMBER
RDG-15-053

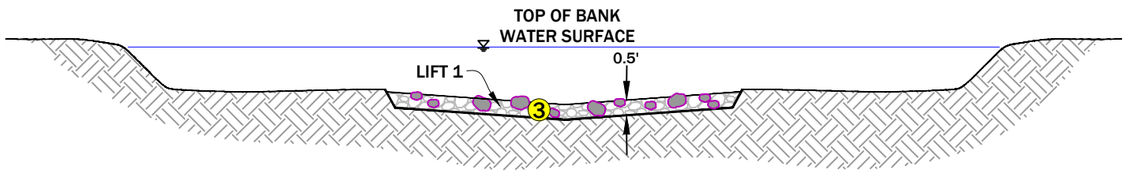
SHEET NUMBER
7.2



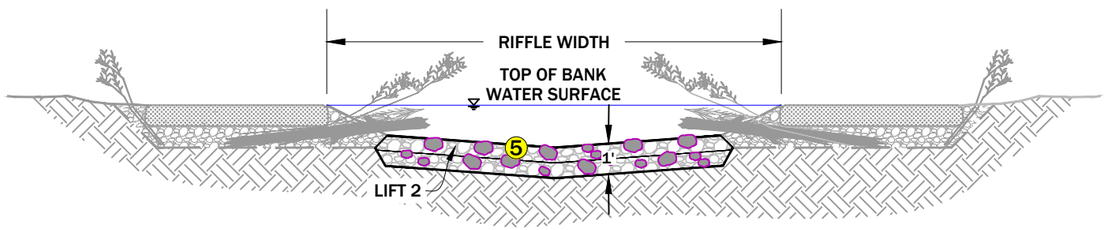
RIFFLE CONSTRUCTION
PLAN VIEW NTS



RIFFLE CONSTRUCTION
PROFILE VIEW NTS



LIFT 1
A - A' NTS



LIFT 2
A - A' NTS

DESIGN INTENT

THE PURPOSE OF THIS STRUCTURE IS TO PROVIDE VERTICAL STABILITY BETWEEN POOLS AND/OR MEANDER BENDS. THE STRUCTURE IS COMPOSED OF A WELL-GRADED MIX OF ALLUVIAL SUBSTRATES THAT REPLICATE NATURAL STREAMBED MATERIALS. A BOULDER FRAMEWORK MAY BE ADDED TO PROVIDE ADDITIONAL STABILITY.

CONSTRUCTION NOTES

1. EXCAVATE STREAMBED TO SUBGRADE ELEVATIONS. THE ENGINEER WILL CONFIRM WHETHER SUBGRADE EXCAVATION AND RIFFLE CONSTRUCTION ARE NECESSARY BASED ON OBSERVED SUBSTRATE CONDITIONS.
2. PLACE RIVERBED FILL IN TWO LIFTS. IF SPECIFIED, PLACE BOULDER FRAMEWORK BEFORE RIVERBED FILL.
3. PLACE THE FIRST LIFT OF RIVERBED FILL AND COMPACT USING WEIGHT OF EQUIPMENT.
4. WASH FINES AND WATER FROM ONSITE INTO THE RIVERBED FILL OF THE FIRST LIFT TO SEAL THE VOIDS.
5. PLACE THE SECOND LIFT USING MINIMAL COMPACTION.
6. WASH FINES AND WATER FROM ONSITE INTO THE RIVERBED FILL OF THE FIRST LIFT TO SEAL THE VOIDS.
7. GRADE THE RIVERBED TO MATCH FINISHED GROUND ELEVATIONS. LARGER ROCKS MAY PROJECT ABOVE THE FINISHED RIVERBED ELEVATION AS SHOWN.

MATERIAL SCHEDULE (PER LINEAR FOOT)

	ITEM	DIAMETER (IN)	QUANTITY
2	RIVERBED FILL	SEE GRADATION	0.4 CY

RIVERBED FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
8	100	D100
4-6	90 - 100	D95
2-4	50 - 80	D65
1-2	30 - 50	D35
0.5-1.0	10 - 30	D15
FINES	0	

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RIFFLE CONSTRUCTION DETAIL
UPPER SPOTTED DOG CREEK
NEAR AVON, MONTANA

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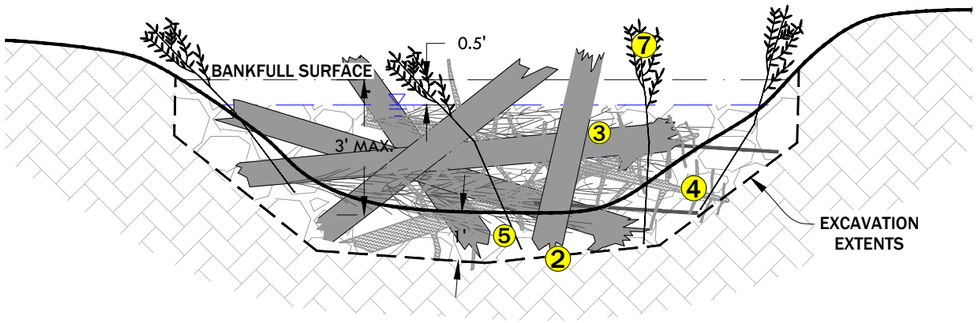
RDG-15-053

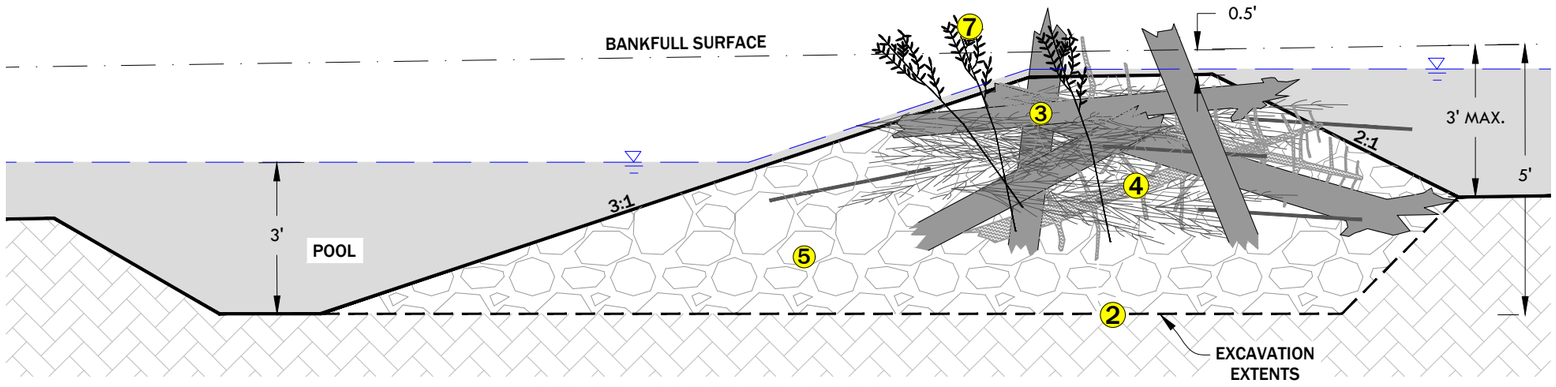
SHEET NUMBER
7.3

EXAMPLE OF AN EXISTING FUNCTIONING BEAVER DAM

EXAMPLE OF AN EXISTING FUNCTIONING BEAVER DAM



BEAVER HABITAT STRUCTURE
SECTION VIEW
0' 1.5' 3'



BEAVER HABITAT STRUCTURE
PROFILE VIEW
0' 1.5' 3'

DESIGN INTENT

PURPOSE: BEAVER HABITAT STRUCTURES ARE CHANNEL-SPANNING STRUCTURES THAT MIMIC OR REINFORCE NATURAL BEAVER DAMS. THE PURPOSE OF THESE STRUCTURES IS TO PROVIDE FUNCTIONS THAT HAVE BEEN LOST AS THE RESULT OF DECREASED BEAVER ACTIVITY IN THE PROJECT REACH.

PLACEMENT CRITERIA: FOR SPOTTED DOG CREEK, THE FOLLOWING PLACEMENT CRITERIA APPLY TO BEAVER HABITAT STRUCTURES:

- PLACE WHERE THERE IS 3 FEET OR LESS OF CHANNEL INCISION TO ENSURE FLOODPLAIN RECONNECTION CAN BE ACHIEVED.
- PLACE IN CLOSE PROXIMITY TO EXISTING WILLOW SOURCES TO ENCOURAGE BEAVER TO ADOPT AND MAINTAIN THE STRUCTURES.
- CONSTRUCT IN CLOSE PROXIMITY TO THE EXISTING BEAVER COMPLEX TO INCREASE POTENTIAL FOR BEAVER TO ADOPT AND MAINTAIN THE STRUCTURES.
- PLACE WHERE OLD DAMS WERE LOCATED OR USE STRUCTURES TO REINFORCE OLD DAMS.
- PLACE AT UPSTREAM OR DOWNSTREAM ENDS OF OLD RETURN CHANNEL LOCATIONS (FROM FORMER BEAVER DAM PONDING) SO THERE ARE CONDUITS TO ROUTE WATER FURTHER OUT INTO THE FLOODPLAIN.
- CONSTRUCT STRUCTURES IN 3 REACHES CONSISTING OF A SERIES OF 5 STRUCTURES PER REACH SPACED BETWEEN 50 AND 100 FEET APART.
- EXACT STRUCTURE LOCATIONS WILL BE STAKED IN THE FIELD PRIOR TO CONSTRUCTION.

SUPPLEMENTAL INFORMATION: BEAVER HABITAT STRUCTURES MIMIC HYDRAULICS CREATED BY NATURAL BEAVER DAMS BY REDUCING STREAM VELOCITIES AND RAISING THE WATER SURFACE ELEVATION UPSTREAM OF EACH STRUCTURE. THIS ACTION WILL RESULT IN AGGRADATION OF THE CHANNEL BED UPSTREAM OF THE STRUCTURE RESULTING IN ELEVATION OF THE WATER TABLE IN THE FLOODPLAIN. THIS WILL HELP RESTORE FLOODPLAIN CONNECTIVITY, INCREASE RIPARIAN VEGETATION VIGOR AND HELP NATURAL EXPANSION OF RIPARIAN VEGETATION. THESE HABITAT STRUCTURES ARE ALSO EXPECTED TO CREATE POOL HABITAT AND ENCOURAGE EXPANSION OF THE NATURAL BEAVER POPULATION IN THE PROJECT REACH. THE SUCCESS OF THESE STRUCTURES ON RESTORING FLOODPLAIN CONNECTIVITY AND EXPANDING RIPARIAN VEGETATION RELIES ON THE STRUCTURE BEING RE-BUILT IF THEY ARE BREACHED DURING NATURAL FLOOD EVENTS.

CONSTRUCTION NOTES

1. INSTALL EROSION CONTROL MEASURES DOWNSTREAM OF THE INSTALLATION SITE.
2. EXCAVATE STREAMBANK AND CHANNEL BED TO SUBGRADE ELEVATION.
3. PLACE SMALL LOGS IN THE STREAMBANK AND CHANNEL BED ORIENTED AS SHOWN ON THE DRAWINGS. LOGS SHALL BE PLACED UP TO 0.5 FEET ABOVE THE BANKFULL ELEVATION. LOGS WILL OVERLAP AND SHOULD EXTEND INTO THE STREAMBANK AND STREAMBED EXCAVATION.
4. PLACE SALVAGED WILLOW STEMS AND BRANCHES WITHIN THE MATRIX OF SMALL LOGS. STEMS AND BRANCHES SHALL BE PLACED UP TO 0.5 FEET ABOVE THE BANKFULL ELEVATION.
5. BACKFILL BRUSH AND LOG MATRIX WITH COBBLE/GRAVEL FILL PER THE GRADATION SHOWN ON THE DRAWINGS.
6. PLACE FINE TEXTURED MATERIAL ON THE UPSTREAM SIDE OF THE STRUCTURE FOLLOWED BY ANOTHER LAYER OF COBBLE/GRAVEL FILL.
7. CONSTRUCT APRON DOWNSTREAM OF LOG AND PLACE WILLOW STEMS/BRANCHES ON THE APRON TO MIMIC ORIENTATION ON EXISTING BEAVER DAMS AS SHOWN ON THE DRAWINGS.
8. CONSTRUCT POOL DOWNSTREAM OF APRON TO THE DIMENSIONS SHOWN ON THE DRAWINGS.

STREAMBED FILL GRADATION

SIZE (INCHES)	PERCENT PASSING	REPRESENTATIVE SIZE CLASS
8	100	D100
4-6	90 - 100	D95
2-4	50 - 80	D65
1-2	30 - 50	D35
0.5-1.0	10 - 30	D15
FINES	0	

MATERIAL SCHEDULE (PER STRUCTURE)

ITEM	QUANTITY	DIA. (IN)	LENGTH (FT)
2 CY OF SUBGRADE EXCAVATION	4		
5 CY OF FILL	10		
3 SMALL WOOD	6	3-6	8-10
4 BRUSH WOOD	10	1-3	8-10
7 CUTTINGS	10	0.75-1.5	6-8

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BEAVER HABITAT STRUCTURE DETAIL
UPPER SPOTTED DOG CREEK
NEAR AVON, MONTANA

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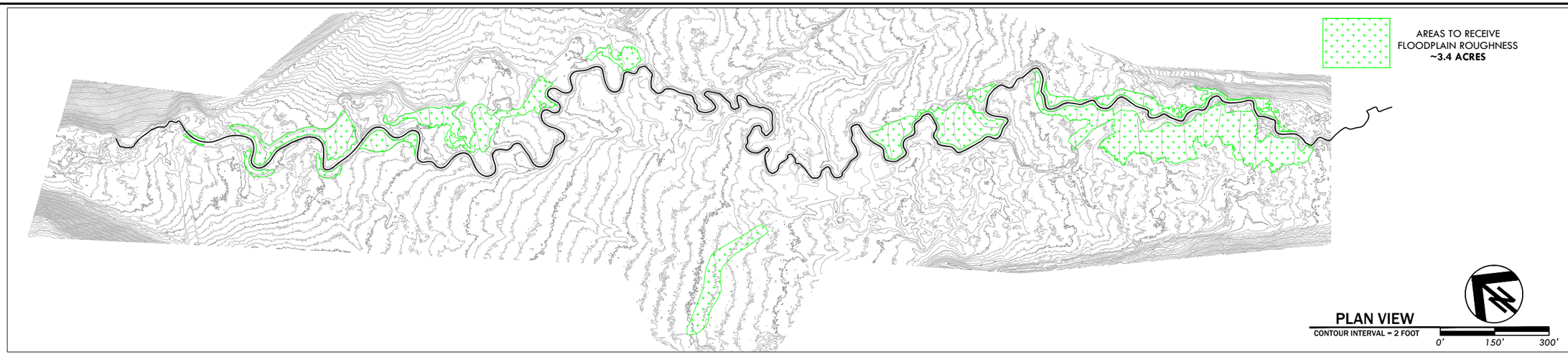
PROJECT NUMBER
RDG-15-053

SHEET NUMBER
7.4



DESIGN INTENT

PURPOSE: THE PURPOSE OF THIS TREATMENT IS TO CREATE CHARACTERISTICS ON NEWLY CONSTRUCTED FLOODPLAIN SURFACES THAT ARE SIMILAR TO THE CONDITIONS ON NATURAL, VEGETATED FLOODPLAIN SURFACES.

PLACEMENT CRITERIA: TREATMENTS ARE APPLIED TO FLOODPLAIN SURFACES THAT LACK ROUGHNESS ELEMENTS AND VEGETATION.

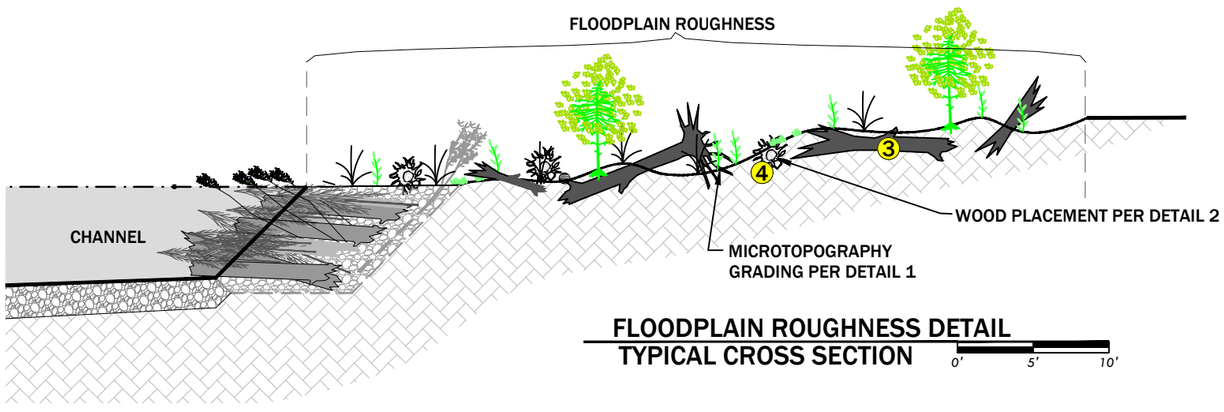
SUPPLEMENTAL INFORMATION: FLOODPLAIN ROUGHNESS TREATMENTS REDUCE THE RISK OF SURFACE EROSION AND INCREASE THE RETENTION OF SEDIMENT AND NUTRIENTS FOR THE DEVELOPMENT OF RIPARIAN VEGETATION. FLOODPLAIN ROUGHNESS IS APPLIED USING TWO METHODS: (1) MICROTOPOGRAPHY GRADING AND (2) WOODY DEBRIS PLACEMENT. MICROTOPOGRAPHY GRADING WILL CREATE AN UNEVEN SURFACE OF FURROWS AND RIDGES ON THE FLOODPLAIN. WOODY DEBRIS WILL PROVIDE STABILITY AND CONTRIBUTE ORGANIC MATTER TO FLOODPLAIN SOILS. PROPER ANCHORING OF WOODY DEBRIS IS REQUIRED TO PREVENT MOVEMENT DURING OVERBANK FLOWS.

CONSTRUCTION NOTES

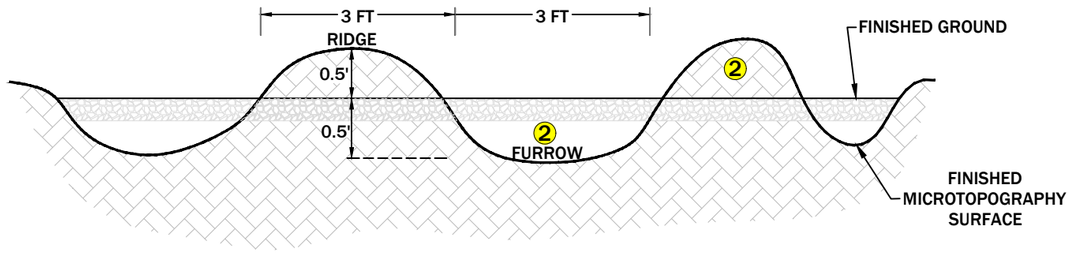
1. CONSTRUCT FLOODPLAIN ROUGHNESS AFTER FINISHED GRADING AND AFTER PLACEMENT OF VEGETATIVE FILL FOR GROWTH MEDIA. CONSTRUCT FLOODPLAIN ROUGHNESS PRIOR TO SEEDING, PLANTING AND FENCING.
2. GRADE FURROWS AND RIDGES INTO THE FINISHED GROUND SURFACE.
3. PARTIALLY BURY SMALL LOGS INTO FURROWS AND RIDGES AT SPACING OF 30 FEET AND A DEPTH OF TWO FEET WITH ONE HALF THE LOG LENGTH BELOW THE SURFACE.
4. PARTIALLY BURY BRUSH INTO FURROWS AND RIDGES AT SPACING OF 15 FEET AND A DEPTH OF TWO FEET WITH ONE HALF THE BRUSH LENGTH BELOW THE SURFACE.

WOOD PLACEMENT CRITERIA

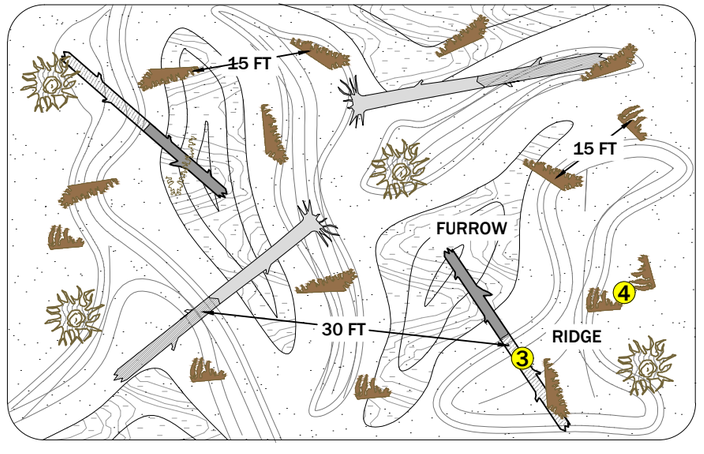
ITEM	DIA. (IN)	LENGTH (FT)	ROOTWAD (Y/N)	LIMBS	SPACING	BURIAL	RATE
3 SMALL WOOD	3-6	8-10	OPTIONAL	YES	30 FT	50%	50/ACRE
4 BRUSH	1-3	8-10	OPTIONAL	YES	15 FT	50%	150/ACRE



FLOODPLAIN ROUGHNESS DETAIL
TYPICAL CROSS SECTION
0' 5' 10'



DETAIL 1 - MICROTOPOGRAPHY GRADING
SECTION VIEW
NTS



DETAIL 2 - MICROTOPOGRAPHY AND
FLOODPLAIN WOOD PLACEMENT DETAIL
TYPICAL PLAN VIEW
NTS

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FLOODPLAIN ROUGHNESS DETAIL
UPPER SPOTTED DOG CREEK
NEAR AVON, MONTANA

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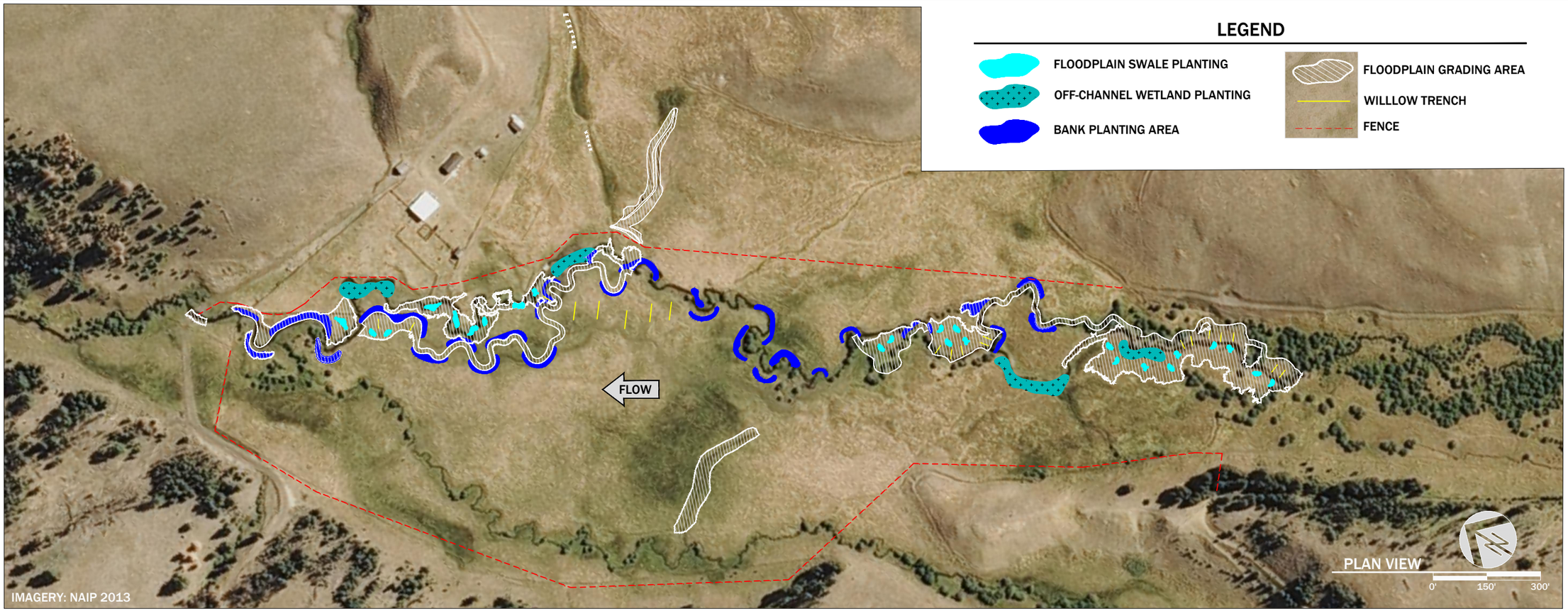
SHEET NUMBER
7.5



BROADCAST SEEDING

THE INTENT OF BROADCAST SEEDING IS TO PROVIDE RAPID ESTABLISHMENT OF DESIRED NATIVE SPECIES IN DISTURBED OR NEWLY CONSTRUCTED AREAS. BROADCAST SEEDING SHOULD OCCUR IN AREAS OF NEWLY CONSTRUCTED FLOODPLAIN AND OTHER DISTURBED AREAS SUCH AS ACCESS ROUTES AND STAGING AREAS. SEED SHOULD BE PLANTED USING THE BROADCAST METHOD, WHEREBY SEED IS SCATTERED ON THE SURFACE OF THE GROUND INSTEAD OF PLANTED IN THE GROUND. SEED MIXES AND SEEDING RATES WILL DEPEND ON THE FINAL SEED MIXES DETERMINED FOR THE SITE. PRELIMINARY COMMERCIAL SEED MIXES AND SEEDING RATES ARE PROVIDE ON SHEET '8.1 PLANTING AND SEEDING SCHEDULE'.

WOODY VEGETATION PLANTING

THE INTENT OF WOODY VEGETATION PLANTING IS TO ESTABLISH DESIRED RIPARIAN VEGETATION ALONG THE NEWLY CONSTRUCTED CHANNEL TO PROVIDE STABILITY AND INCREASE HABITAT FOR AQUATIC AND TERRESTRIAL SPECIES. CONTAINERIZED WOODY PLANTS SHOULD BE INSTALLED IN THE AREAS SPECIFIED AS PLANTING AREAS ON SHOWN ABOVE. SPECIES TO BE PLANTED ARE PROVIDED ON SHEET '8.1 PLANTING AND SEEDING SCHEDULE'. FLOODPLAIN PLANTING INCLUDES PLANTING TALL ONE GALLON (4” X 4” X 14”) SIZED PLANTS. PLANT SPACING IS APPROXIMATELY 6 FOOT ON CENTER IN ALL PLANTING AREAS. EXACT PLANTING LOCATIONS, PLANT SPACING AND SPECIES TO PLANT IN EACH PLANTING AREA WILL BE DETERMINE BY THE ENGINEER PRIOR TO PLANTING.

PLANTS CAN BE PLANTED BY HAND OR WITH AN AUGER. PLANTING HOLES SHOULD BE AT LEAST TWO TIMES THE DIAMETER OF THE PLANTING CONTAINER. PLANTS SHOULD BE PLANTED SO THAT THEIR ROOT COLLARS ARE FLUSH WITH THE FINAL GROUND SURFACE. PLANTS SHOULD BE REMOVED FROM THEIR CONTAINERS AND THE ROOTS LOOSENED IF THEY ARE EXCESSIVELY ROOT BOUND. THE SOIL IN AND AROUND THE PLANTING HOLE SHOULD BE LOOSENED TO ALLOW THE ROOTS TO EXPAND FREELY ONCE THE SHRUB IS PLANTED. ONCE THE SHRUB IS IN THE PLANTING HOLE, THE HOLE SHOULD BE BACK FILLED AND GENTLY TAMPED TO REMOVE ANY AIR POCKETS. CONTAINERIZED WOODY PLANTS SHOULD BE WATERED IN USING 5 GALLONS OF WATER. AFTER WATERING IN, ADDITIONAL SOIL SHOULD BE ADDED TO FILL THE PLANTING HOLE IF NEEDED.

INDIVIDUAL PLANT PROTECTORS

INDIVIDUAL PLANT PROTECTORS SHOULD BE INSTALLED AFTER INSTALLATION OF WOODY PLANTS AS DIRECTED BY THE ENGINEER. ALL WOODY PLANTS SHOULD BE FIT WITH AN INDIVIDUAL PLANT PROTECTOR. INDIVIDUAL PLANT PROTECTORS SHOULD CONSISTS OF 48” TALL WOVEN WIRE OR RIGID POLYETHYLENE MESH FORMED INTO A 20” DIAMETER CYLINDER. WIRE MESH SHOULD HAVE OPENINGS NO LARGER THAN 2” X 2”. WIRE MESH CAN BE SECURED TO 48” T-POSTS OR 48” X 2” X 2” WOODEN STAKES USING 12” UV STABILIZED CABLE OR ZIP TIES. PROTECTORS SHOULD BE FLUSH WITH THE GROUND.

WILLOW TRENCH

THE INTENT OF WILLOW TRENCHES IS TO ESTABLISH WILLOWS IN THE FLOODPLAIN AWAY FROM THE CHANNEL AND PROVIDE SURFACE ROUGHNESS IN THE FLOODPLAIN. WILLOW TRENCHES CONSIST OF 3-4 FOOT DEEP TRENCHES DUG IN THE FLOODPLAIN, PERPENDICULAR TO THE VALLEY BOTTOM. WILLOW CUTTINGS ARE THEN PLACED IN THE TRENCH AND BACK-FILLED TO MATCH THE ADJACENT GROUND SURFACE ELEVATION. WILLOW CUTTINGS SHOULD BE PLACED SO THAT EACH CUTTING IS IN CONTACT WITH THE BOTTOM OF THE TRENCH. WILLOW CUTTINGS SHOULD ALL BE ORIENTED THE SAME DIRECTION TO PREVENT DAMAGE OF CUTTINGS DURING TRENCH BACKFILL. WILLOW CUTTINGS SHOULD BE PLACED AT A RATE OF 5 PER LINEAR FOOT OF TRENCH.

SWALE GRADING

THE INTENT OF SWALE FEATURES IS TO PROVIDE TOPOGRAPHIC HETEROGENEITY IN THE FLOODPLAIN TO ALLOW RIPARIAN SHRUBS TO ESTABLISH. SWALES NATURALLY RECRUIT SEDIMENTS, NUTRIENTS AND SEED TRANSPORTED BY WATER AND WIND AND SERVE AS ZONES OF NATURAL PLAN RECRUITMENT. SWALE FEATURES WILL BE CONSTRUCTED IN THE APPROXIMATE LOCATIONS SHOWN ABOVE. SWALE FEATURES SHOULD BE BETWEEN 20 AND 30 FEET IN LENGTH AND BETWEEN 10 AND 20 FEET IN WIDTH. SIDE SLOPES OF SWALE FEATURES SHOULD NOT EXCEED 3 FEET HORIZONTAL FOR EVERY 1 FOOT VERTICAL. THE BOTTOM OF SWALES SHOULD BE AT AN ELEVATION APPROXIMATELY EQUAL TO THE BOTTOM OF THE CONSTRUCTED SPOTTED DOG CHANNEL THAT IS ADJACENT TO THE SWALE LOCATION. EXACT SWALE DIMENSIONS AND LOCATIONS WILL BE STAKED BY THE ENGINEER DURING CONSTRUCTION.

WETLAND GRADING

THE INTENT OF OFF CHANNEL WETLANDS IS TO PROVIDE TOPOGRAPHIC HETEROGENEITY IN THE FLOODPLAIN AND CREATE ELEVATIONS BETWEEN BANKFULL STAGE AND TWO FEET BELOW BANKFULL STAGE TO INTERCEPT GROUNDWATER DURING THE SPRING AND GROWING SEASON. WETLANDS WILL BE CONSTRUCTED IN AREAS WHERE THE CHANNEL IS ABANDONED IN THE APPROXIMATE LOCATIONS SHOWN ABOVE. THE EXACT LOCATIONS AND DIMENSIONS OF WETLAND FEATURES WILL BE IDENTIFIED BY THE ENGINEER PRIOR TO CONSTRUCTION. WETLAND GRADING WILL VARY FROM SITE TO SITE. OFF CHANNEL WETLAND DIMENSIONS WILL VARY DEPENDING ON THE LOCATION AND THE AMOUNT OF FILL AVAILABLE TO CREATE THE WETLAND FEATURE. IN GENERAL, OFF CHANNEL WETLAND FEATURES ARE BETWEEN 20 AND 30 FEET IN LENGTH WITH A MAXIMUM DEPTH OF 2 FEET AND A MAXIMUM SLOPE OF 10:1.

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FLOODPLAIN TREATMENT PLAN

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PROJECT NUMBER
RDG-15-053

SHEET NUMBER
8.0

Woody Containerized Plant Mix			
Common Name	**Scientific Name**	**Container Size**	**Number of Plants**
thin leaf alder	*Alnus incana*	4” x 4” x 14”	300
red-osier dogwood	*Cornus sericea*	4” x 4” x 14”	200
bebb willow	*Salix bebbiana*	4” x 4” x 14”	400
Booth’s willow	*Salix boothii*	4” x 4” x 14”	450
Drummond's willow	*Salix drummondiana*	4” x 4” x 14”	400
		Total	**1,750**

Riparian/Floodplain Seed Mix			**Area: 4 acres**
Common name	**Scientific Name**	**PLS #/ac**	**Total PLS Pound**
Graminoids			
mountain brome	*Bromus marginatus*	6.0	24
bluejoint reedgrass	*Calamagrostis canadensis*	0.3	1.2
Bebb's sedge	*Carex bebbii*	0.4	1.6
Tufted hairgrass	*Deschampsia cespitosa*	0.4	1.6
thickspike wheatgrass	*Elymus lanceolatus*	4.0	16
slender wheatgrass	*Elymus trachycaulus*	6.0	24
Baltic rush	*Juncus balticus*	0.1	0.4
western wheatgrass	*Pascopyrum smithii*	6.0	24
Forbs			
common yarrow	*Achillea millefolium*	0.1	0.4
	Totals	**23.3**	**93.2**

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PLANTING AND SEEDING SCHEDULE
UPPER SPOTTED DOG CREEK
NEAR AVON, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	3-11-16	NW	DESIGN	MD
2	1-02-20	NW	DESIGN REVISIONS	MD

PROJECT NUMBER
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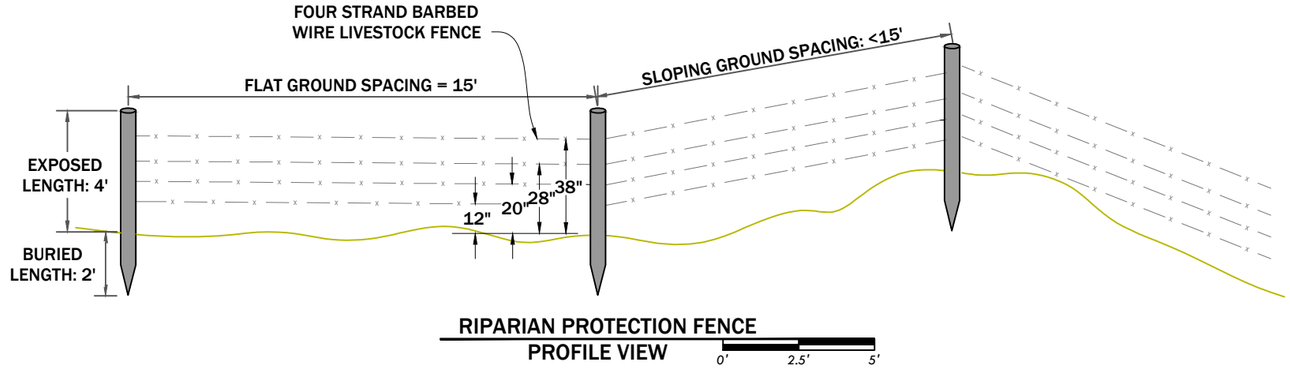
8.1



RIPARIAN PROTECTION FENCE
PROFILE VIEW

0' 2.5' 5'

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RIPARIAN PROTECTION FENCE DETAIL

UPPER SPOTTED DOG CREEK NEAR AVON, MONTANA

NO.	DATE	BY	DESCRIPTION	CHK
1	3-11-16	NW	DESIGN	MD
2	1-02-20	NW	DESIGN REVISIONS	MD

PROJECT NUMBER
RDG-15-053

SHEET NUMBER

8.2